The blending system would be utilized whenever the surface water nitrate concentration is at or above a recommended pre-set level of approximately 9 mg/l and rising.

The well system could be automated to allow for remote pump operation and monitoring from the treatment plant. This would allow the duty operator to control both sources, and thus, the finished water nitrate concentration, from one location, eliminating the need for an operator to drive to the wellfield to make flow adjustments in response to varying surface water conditions.

d. Results/Conclusions of Groundwater Investigation

Although CIWC was ultimately granted permission by the courts to perform groundwater testing, CIWC did not go forward with the testing based on further consideration and developments. As more nitrate data became available for the years following the raising of the Lake, a pattern of a decrease in nitrate violations and duration became apparent as discussed previously in this chapter of the report. Therefore, the number of expected days per year of nitrate treatment was reduced, which then made other alternatives, specifically ion exchange, more favorable from a cost standpoint, even when assuming that groundwater would be available near the Village of Henning, which would be at the most favorable location with respect to the treatment plant.

In addition, both a safe yield study and a sedimentation study were performed on the Lake in 1997 and 1998, respectively. Both studies indicated that there is adequate water in Lake Vermilion for the future under a variety of drought conditions (up to a 50-year drought). Also, the D/DBP rule and the IESWTR were formulated and did not result in as stringent of standards as anticipated, which further reduced the need for groundwater as a second supply.

e. Summary

Blending utilizing a groundwater source is a viable option from a technical standpoint. However, based on the results and conclusions of the initial groundwater investigation and in light of recent developments with regard to the current nitrate situation, it is not a feasible option due to the associated costs when compared with other alternatives. The cost analyses for the most favorable groundwater option are developed in Chapter 8 for capital and operating and maintenance costs as well as present value revenue requirements. In addition, there are several risks associated with this alternative, which include the possibility that sufficient groundwater is not available and that it would be difficult to acquire the needed land for well development. There is considerable landowner opposition to the development of a "rural" groundwater site to serve the people of Danville. Also, additional testing would be required to determine the extent of the viability of this alternative.

5. Ion Exchange

An alternative approach to supplementing the surface supply is further treatment of the existing supply. One method of reducing nitrates utilizes an ion exchange resin to exchange more desirable ions for the less desirable nitrate ions in solution.

a. Process Description

In the ion exchange process for nitrate removal, nitrate containing water passes through a media bed comprised of a high capacity anion exchange resin with a final gravel support media. Nitrates, sulfates, and alkalinity are exchanged for chlorides on the strongly basic anion resin.

The exchange capacity is largely governed by the concentrations of nitrates and sulfates which are retained until breakthrough of unwanted ions occurs. Prior to breakthrough, sometimes called exhaustion, the process is regenerated using a strong chloride solution. The basic chemical reactions are reversible as follows:

In Service:

$$RCl + NaNO_3 = RNO_3 + NaCl$$

Regeneration:

$$RNO_3 + NaCl = RCl + NaNO_3$$

where R = anion exchange resin.

The basic ion exchange process is configured in several modes. The first, called co-current regeneration, regenerates the resin in the same flow direction as the in-service flow. This mode requires a backwash following each service run to relieve compaction of the bed and remove any collected particulates.

The second mode, referred to as counter-current regeneration, utilizes an upflow regeneration and slow rinse and a downflow in-service configuration. This results in lower leakage rates through the bed. The major disadvantage of this system is that higher capital costs are required to configure the two flow modes. This must be compared against lower operation and maintenance costs and higher quality effluent.

The third mode, known as a continuous contactor, never takes the reactor out of service. Instead the resin bed is moved through a cycle in which a portion of the resin is constantly being regenerated. The disadvantages of this system are the higher capital and maintenance costs.

Each of the three ion exchange operating configurations were investigated and then evaluated based on cost and operating parameters. The following Table 7-2 summarizes the operating parameters for each mode based on Hungerford & Terry co- and counter-current systems and on Advanced Separation Technologies for the continuous ion exchange system. The cost analyses for each of the three ion exchange options are developed in Chapter 8.

TABLE 7-4
ION EXCHANGE OPERATING MODES

ITEM	CO-CURRENT	COUNTER-CURRENT	CONTINUOUS CONTACTOR
No. of Exchange Units	4	4	30
Normal Pressure Drop, psi	10	10	10
Max. Pressure Drop, psi	25	25	25
Control	PLC	PLC	PLC
Bulk Brine Tank, Tons	88	88	72
Water Softener	No	Yes	Yes
Ion Exchange Resin, cu. ft.	1256	1572	725
Waste Per Treated Water	19 gal/1000 gal	14 gal/1000 gal[1]	4 gal/1000 gal
Waste Produced Per Yr.	1.63 MG	1.14 MG	0.32 MG
Salt Per Treated Water	4.0 lb/1000 gal	2.7 lb/1000 gal	2.5 lb/1000 gal
Salt Usage Per Yr.	170 tons	105 tons	98 tons
Footprint	40 ft x 50 ft	40 ft x 50 ft	36 ft x 50 ft

[1]Assumes use of air-blocking during regeneration. Air blower is included.

Regardless of the mode, the ion exchange process generates a waste stream, which contains concentrated nitrates that have been removed and must be disposed of properly. The Sanitary District has indicated that they would accept this nitrate waste based on a total annual volume charge and a sulfate loading surcharge. If this method of disposal would be implemented, additional force main would have to be constructed, and the current lift station would have to be expanded to effectively convey this waste to the Sanitary District. Alternatively, CIWC could explore the possibility of obtaining a new National Pollutant Discharge Elimination System (NPDES) permit, which would allow the waste stream to be directly discharged to a receiving stream. One possible discharge point would be Horseshoe Pond, which is located in front of the treatment plant. Another option would be to modify an existing NPDES permit to allow the waste to be discharged to the existing sludge lagoons. These options should be explored as either would provide considerable cost savings when compared to discharging to the Sanitary District.

b. System Requirements

Based on the cost analyses detailed in Chapter 8 for the different ion exchange alternatives, the low cost alternative was further considered for this report, which is the counter-current system. Both previous studies with Lake Vermilion water and recent correspondences with an ion exchange manufacturer indicate that an effluent nitrate concentration of 2 mg/l would be easily achievable given both the average and maximum historical influent values of 12.7 and 15.6 mg/l, respectively. In order to meet the finished water goal of 9 mg/l as N, it would be required to treat only a portion of the influent for nitrate. The balance could be "blended around" this process, and the combined water would then safely meet the standard.

The overall treatment capacity goal would be 10 mgd of finished water at less than 9 mg/l of nitrate as N based on average and maximum influent nitrate concentrations of 12.7 and 15.6 mg/l, respectively. At worst case conditions, this would require a reliable ion exchange capacity of 3056 gpm. This capacity could be provided through four treatment vessels each with a treatment capacity of 764 gpm. The four vessels would provide the required total maximum capacity. At average conditions, the required flow to be treated by the ion exchange system would be 1821 gpm, which could be provided through three treatment vessels with one unit out of service for regeneration or repair.

The ion exchange system would be housed in a prefabricated steel structure enclosing an approximate surface area of 3000 square feet. The structure would be located at the north end of the existing reservoir. The flow configuration would include the conventionally filtered water piped into the existing reservoir with a fraction being discharged into the reservoir and the required balance would be piped to the ion exchange system. The effluent from the ion exchange system would then be discharged into the reservoir. The structure location and piping configuration is shown in Exhibit 7-11.

c. Summary

The ion exchange process is a feasible treatment alternative from a technical standpoint because it provides a low nitrate concentration effluent, which could be blended to meet the nitrate finished water goal of 9 mg/l N. This option also requires salt for regenerations and periodic resin replacement. The waste disposal cost for this alternative is based on discharging to the Sanitary District. However, the option of obtaining a new NPDES permit or modifying an existing permit should be investigated as it would provide considerable savings when compared to discharging to the Sanitary District. As mentioned previously, capital and operating costs for all three ion exchange alternatives are included in Chapter 8.

5. Nanofiltration

Nanofiltration is a membrane-based process similar to reverse osmosis. Nanofiltration is sometimes referred to as "leaky reverse osmosis." Basically, the process utilizes pressure to force water through a semi-permeable membrane. The membrane systems used for nanofiltration are capable of rejecting contaminants as small as 0.001 μm. Nanofiltration also has been shown to completely reject contaminants with a molecular weight greater than 190 to 200 daltons. The molecular weight of nitrate is considerably lower than this. Therefore, a significant portion of the nitrate is allowed to pass through to the product water. Because there would not be significant nitrate reduction in the nanofiltration effluent, this technology is infeasible for the given situation.

6. Reverse Osmosis (RO)

The most significant difference between reverse osmosis and nanofiltration is that the density of the membrane is greater for RO, which results in a lower molecular cut off weight. As a result of the increased membrane density, a greater pressure differential across the membrane is required to drive the process with pumping requirements ranging from 100 to 300 psi.

RO systems can reliably reject constituents as small as 0.001 µm, or in terms of membrane weight cutoffs, as small as monovalent ions. Consequently, RO systems can effectively remove nitrates.

a. System Description

Typically, RO systems are configured in arrays to generate as large a recovery as possible. Typically, recovery of permeate through any one element is limited to approximately 75%, which means that only 75% of the influent volume is collected as finished water or permeate. The balance of the water remains as concentrate, and the constituents rejected by the membrane are effectively concentrated in this stream. In an array configuration, the concentrate from the first set of modules is then passed through a second set of modules to increase the overall permeate recovery. Typically, this step is repeated one last time to achieve up to 94% recovery through a 4:2:1array.

The high pressures required to force permeate through the semi-permeable membrane require a pumping system dedicated to the RO process. Other appurtenances required include pretreatment (antiscalant) chemical storage and feed equipment, a degassifier, an automatic control system, and a membrane cleaning system including tanks, pumps and controls. In addition, the concentrate waste stream would have to be disposed of properly. One option would be to discharge it to the sanitary sewer, where total annual volume charges and sulfate surcharges would be applied by the Sanitary District and upgrades to the existing wastewater facilities, as described above for the ion exchange process, would be required.

b. System Requirements

Based on the chemistry of Lake Vermilion water, RO system manufacturers project that an RO permeate would have a nitrate concentration of approximately 1.2 mg/l based on an influent nitrate concentration of 12.7 mg/l, the historical average during high nitrate events. Based on this influent concentration and the overall goal of providing 10 mgd capacity of finished water with an effluent nitrate concentration of less than 9 mg/l, an RO capacity of at least 3.2 mgd (2220 gpm) is required. This could be accomplished through two (2) 4:2:1 arrays of modules totaling 42 pressure vessels each (24 first phase, 12 second phase and 6 third phase). This system would be capable of producing 2220 gpm of permeate with a nitrate concentration of 1.2 mg/l as N. This would also produce approximately 145 gpm of concentrate to be disposed of from a total influent of 2360 gpm. This is based on a recovery rate of 94%. Also, 4720 gpm of non-RO treated water would be by-passed around the system to yield 6945 gpm or 10 mgd of blended water with a nitrate concentration of less than 9 mg/l as N. At times when the demands and influent nitrate concentrations are lower than the assumed design parameters, the volume of blended water would be increased and the output of the RO system decreased. At times when the influent nitrate concentrations are above the 12.7 mg/l high nitrate event average, the units can be "pushed" for a period of time. This would result in an accelerated cleaning requirement but enable the Water Company to continue to meet the MCL.

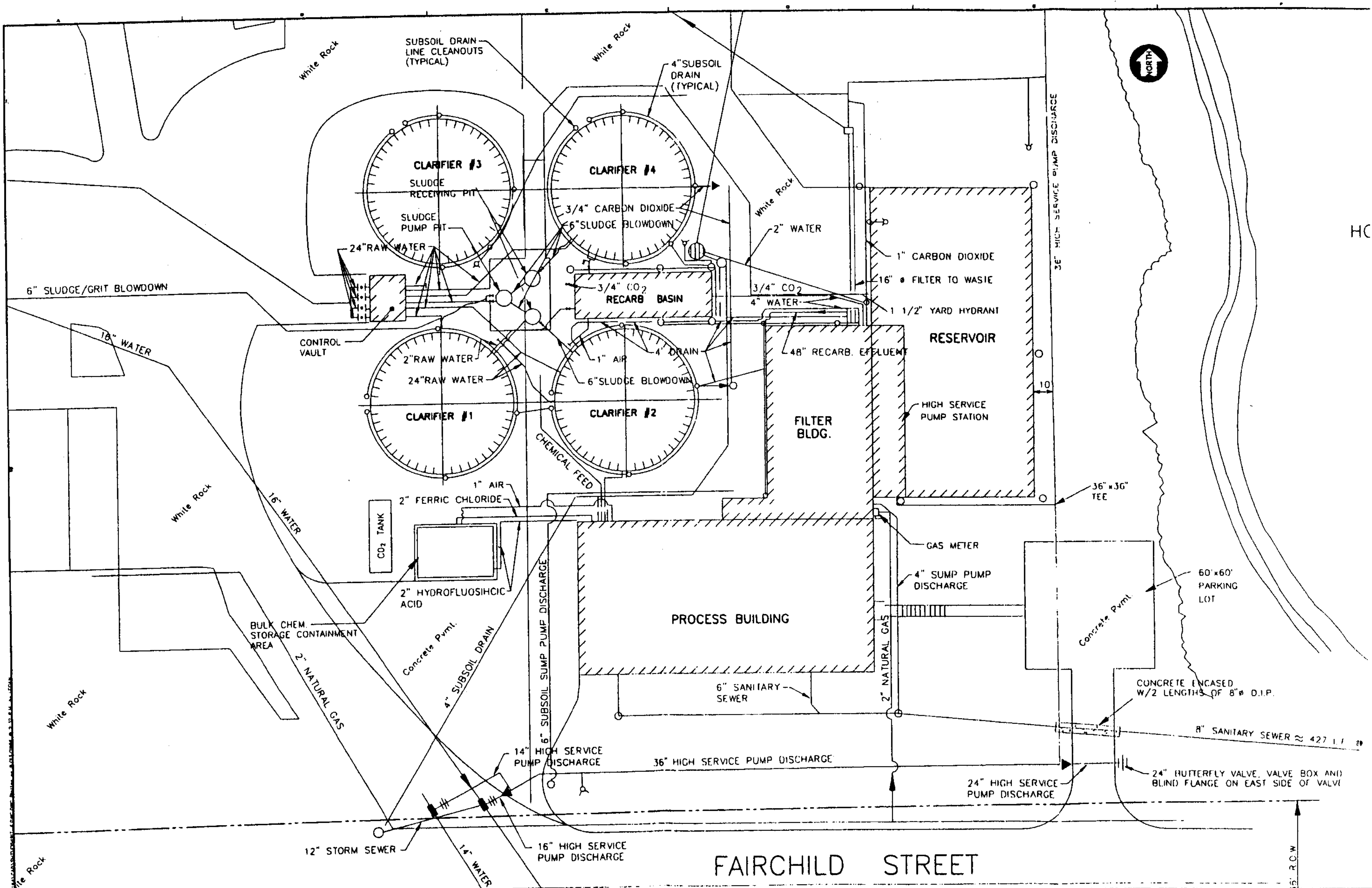
The RO system could also be taken off line for long periods of time when nitrate levels are well below the 10 mg/l standard.

Assuming that the plant's effluent would be the feed to the RO system, the RO influent would require a sufficient dose of sulfuric acid to bring the pH of the water down from 8.8 to 7.0, which would require approximately 470 lb/day at design capacity. The process would also require an antiscalant dose of approximately 2 ppm to prevent formation of calcium sulfate due to the addition of acid. The RO permeate would be treated by a degassifier which would remove the dissolved carbon dioxide from the permeate and decrease the aggressive nature of the product water.

The RO system would be housed in a prefabricated steel structure enclosing an area of 2520 square feet located north of the existing reservoir, and the piping configuration would be the same as was previously described for the ion exchange system. Exhibit 7-11 illustrates the structure location and piping configuration.

c. Summary

Reverse osmosis would effectively treat the high nitrate concentrations providing an effluent that is less than 2 mg/l, which would result in an overall blend below the 9 mg/l goal. Capital and operational costs for this alternative are discussed in Chapter 8.



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CONSUMERS ILLINOIS WATER COMPANY
DANVILLE (VERMILION) WATER TREATMENT PLANT
IMPROVEMENT PROJECT

CTE ENGINEERS
CONSOER TOWNSEND ENVIRODYNE ENGINEERS INC

EXISTING SITE PLAN

SHEET EXHIBIT 6-1
OF
CTE PROJECT NO. 44143

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CHAPTER 8
ALTERNATIVE EVALUATIONS

Evaluations of the alternatives discussed in Chapter 7 are based on several factors and are discussed here.

A. FINISHED WATER QUALITY

Only those treatment alternatives discussed in Chapter 7 that would result in an acceptable water quality were pursued to any great degree. As a result the following options were investigated:

Side Channel Storage
Supplemental Groundwater
Ion Exchange
Reverse Osmosis

Each of these alternatives is capable of providing finished water with a nitrate level below the 9 mg/l goal. The alternatives were sized based on the requirements of providing a total blended effluent flow of 10 mgd below the nitrate 9 mg/l goal. Therefore, each alternative would be capable of providing a similar nitrate concentration in the finished water. Each process, however, would have different effects on the constituents of the finished water as a whole. These points are discussed in this section.

1. Side Channel Storage

The side channel storage option would store low nitrate water off site until it is required for blending due to nitrate levels at or above the 9 mg/l goal in Lake Vermilion. All other water quality parameters such as hardness, alkalinity, and turbidity should be relatively consistent with current Lake Vermilion values with the exception of synthetic organics, which are associated with non-point source agricultural runoff containing pesticides and herbicides. Periods of higher levels of synthetic organics typically correspond to periods of higher nitrates because they both originate from similar sources. Therefore, concentrations of these organics in addition to nitrate concentrations would be somewhat less when the side channel storage water is being utilized. CIWC worked previously with Daily & Associates Engineers, Inc., to investigate the feasibility of this alternative and their data was used to develop this information.

2. Groundwater

Typically, groundwater in the Danville area is relatively high in hardness, total dissolved solids, alkalinity and dissolved iron. If groundwater were to be blended with Lake Vermilion water in order to dilute the nitrate concentration to below the 9 mg/l goal, there would be corresponding increases in hardness as well as in the other parameters. These constituents could be removed through the existing treatment process by making appropriate adjustments in chemical feed rates. The finished water quality should be comparable to the current finished water quality for all parameters with the exception of the nitrate concentration, which would decrease.

3. Ion Exchange

The ion exchange process is a fundamentally different approach from the aforementioned alternatives in that it does not rely on a new water source that is lower in nitrate concentration but rather utilizes the same source water and treats it further to reduce the nitrate concentration.

The ion exchange system would be sized to treat a portion of the total plant flow such that the plant would be capable of producing 10 mgd of blended water with a nitrate concentration below 9 mg/l. The ion exchange process would also remove sulfates from the feed water as they also exhibit a strong affinity for the resins. The resins would exchange chlorides for nitrates and sulfates according to the following reaction where R designates the ion exchange resin:

$$RCl + NaNO_3 + Na_2SO_4 = 2NaCl + RNO_3 + RS0_4$$

Therefore, the chloride concentration of the finished water would increase by approximately two times. No MCL exists for chloride, but the secondary (aesthetic) standard for chloride is 250 mg/l to avoid a saltwater taste. The blended finished water should be well below this standard.

4. Reverse Osmosis

The reverse osmosis (RO) process would also be sized to treat only a portion of the raw water to maintain a blended finished water nitrate concentration below the 9 mg/l goal. Similar to ion exchange, the reverse osmosis unit would treat a percentage of the conventionally treated water from the Lake Vermilion source. As discussed in Chapter 7 of this report, RO is capable of removing all but the smallest molecular compounds. RO is especially suited to remove long chained organic molecules such as atrazine, simizine and cynazine, which have been found in small amounts in Lake Vermilion sourcewater. In addition to removal of these compounds, other organics that may be present and that could be potential THM precursors would be removed by RO. These compounds would not be entirely removed, however, since only about 45% of the total blended flow would be treated through the RO process. All basic parameters of the RO treated water would be well below their respective MCL's. Table 8-1 delineates some of the expected permeate values.

TABLE 8-1
RO PERMEATE CONCENTRATIONS (mg/l)

	Raw Water		Feed Water		Permeate		Concentrate	
Ion	**mg/l**	**as mg/l $CaCO_3$**	**mg/l**	**as mg/l $CaCO_3$**	**mg/l**	**as mg/l $CaCO_3$**	**mg/l**	**as mg/l $CaCO_3$**
Ca	38.8	96.7	38.8	96.7	0.6	1.4	153.4	382.6
Mg	11.1	45.5	11.1	45.5	0.2	0.7	43.8	180.0
Na	21.3	**NA**	21.3	**NA**	1.4	**NA**	80.7	**NA**
K	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NH_4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ba	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sr	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO_3	1.2	2.0	1.2	2.0	0.0	0.0	4.9	8.2
HCO_3	56.5	46.3	56.5	46.3	1.2	1.0	222.3	182.2
SO_4	37.2	**NA**	37.2	**NA**	0.1	**NA**	148.5	**NA**
Cl	28.4	**NA**	28.4	**NA**	0.3	**NA**	112.6	**NA**
F	1.2	**NA**	1.2	**NA**	0.0	**NA**	4.6	**NA**
NO_3	71.8	**NA**	71.8	**NA**	4.3	**NA**	274.1	**NA**
SiO_2	5.0	**NA**	5.0	**NA**	0.0	**NA**	19.9	**NA**
TDS	272.3	**NA**	272.3	**NA**	8.3	**NA**	1064.8	**NA**
pH	8.8	**NA**	8.8	**NA**	7.2	**NA**	8.9	**NA**

NA – Not Applicable

An additional benefit of the RO process is the removal of microscopic particulates to non-detectable levels. This includes particulates down to the macro molecular range, which is much less than the size of microorganisms of concern. Table 8-2 illustrates this point.

TABLE 8-2
SIZE COMPARISON

RO retainage	>0.001 – 0.0001 µm
Giardia cysts	5 – 15 µm
Cryptosporidium oocyst	3 – 5 µm
Coliform bacteria	0.1 – 10 µm
Viruses	0.02 – 0.03 µm

Based on the above discussion, the RO alternative should provide the best quality water. Although, all of the alternatives considered would provide acceptable finished water quality.

A. ECONOMICS

The economic analysis of each of the alternatives investigated is shown below. Each major alternative has been estimated for capital and annual operating costs. These costs were then utilized to project an annual present value of revenue required to meet these costs. As outlined in the design criteria, previously in this report, the period of nitrate treatment operation is assumed to be 90 days over a three year period. Therefore, for cost analyses purposes, this 90- day period was normalized to 30 days per year. Each of the cost estimates presented includes a 20 percent contingency factor. Also, each of the alternatives contains water treatment plant improvements that CTE evaluated and recommended to meet upcoming regulations. They include slurry carbon system, filter improvements, constructing new river intakes, and upgrading the SCADA system.

1. Side Channel Storage

TABLE 8-3
SIDE CHANNEL STORAGE AT CANYON LAKE SITE
ESTIMATED CAPITAL COSTS

DESCRIPTION	QUANTITY	UNITS	UNIT COST	TOTAL COST
*24" Transmission Main	24,000	LF	$70	$1,680,000
Pump Stations	2	LS	$350,000	$700,000
Intake Structures	2	LS	$375,000	$750,000
Earthwork for Reservoir	1	LS	$2,900,000	$2,900,000
Land Acquisition and Easements	1	LS	$900,000	$900,000
Other Water Treatment Plant Improvemetnts[1]	1	LS	$1,040,000	$1,040,000
Sub-Total				$7,970,000
20% Contingency				$1,594,000
Total Construction Cost				$9,564,000
Other Project Costs				$3,372,290
Total Project Cost				**$12,936,290**
*Assumes the use of HDPE Transmission Main				

[1]CTE has recommended that CIWC move forward with water treatment plant improvements to ensure compliance with water quality regulations that include carbon slurry system, filter improvements, new river intakes and upgrading of the SCADA system.

TABLE 8-4
SIDE CHANNEL STORAGE AT CANYON LAKE SITE
ESTIMATED OPERATING COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST/YR
Pumping Cost	1	LS	$15,000	$15,000
Water quality Monitoring & Watershed Mgt.	1	LS	$30,000	$30,000
Total				**$45,000**

TABLE 8-5
SIDE CHANNEL STORAGE AT CANYON LAKE SITE
PRESENT VALUE OF REVENUE REQUIRED

A	B	C	D	E	F	G	H	I	J	K	P.V. of
Year	Total Capital Cost	Year - End Undepr. Factor	Undepreciated Capital	Pretax Rate of Return	Dollar Rate of Return (D x E)	Total O&M Expense *	Depreciation (Excluding Land) (B x 2.5%)	Property Taxes @ 2%	Total Capital Return (F + H + I)	Total Rev. Req'mt (G + J)	Revenue Requirement @ 10%
1	$12,936,290	0.975	$12,633,883	17.00%	$2,147,760	$45,000	$302,407	$252,678	$2,702,845	$2,747,845	$2,498,041
2	$12,936,290	0.950	$12,331,476	17.00%	$2,096,351	$46,350	$302,407	$246,630	$2,645,388	$2,691,738	$2,224,577
3	$12,936,290	0.925	$12,029,068	17.00%	$2,044,942	$47,741	$302,407	$240,581	$2,587,930	$2,635,671	$1,980,218
4	$12,936,290	0.900	$11,726,661	17.00%	$1,993,532	$49,173	$302,407	$234,533	$2,530,473	$2,579,646	$1,761,933
5	$12,936,290	0.875	$11,424,254	17.00%	$1,942,123	$50,648	$302,407	$228,485	$2,473,015	$2,523,663	$1,566,996
6	$12,936,290	0.850	$11,121,847	17.00%	$1,890,714	$52,167	$302,407	$222,437	$2,415,558	$2,467,725	$1,392,967
7	$12,936,290	0.825	$10,819,439	17.00%	$1,839,305	$53,732	$302,407	$216,389	$2,358,101	$2,411,833	$1,237,652
8	$12,936,290	0.800	$10,517,032	17.00%	$1,787,895	$55,344	$302,407	$210,341	$2,300,643	$2,355,988	$1,099,086
9	$12,936,290	0.775	$10,214,625	17.00%	$1,736,486	$57,005	$302,407	$204,292	$2,243,186	$2,300,191	$975,505
10	$12,936,290	0.750	$9,912,218	17.00%	$1,685,077	$58,715	$302,407	$198,244	$2,185,729	$2,244,443	$865,330
11	$12,936,290	0.725	$9,609,810	17.00%	$1,633,668	$60,476	$302,407	$192,196	$2,128,271	$2,188,747	$767,143
12	$12,936,290	0.700	$9,307,403	17.00%	$1,582,259	$62,291	$302,407	$186,148	$2,070,814	$2,133,104	$679,673
13	$12,936,290	0.675	$9,004,996	17.00%	$1,530,849	$64,159	$302,407	$180,100	$2,013,356	$2,077,516	$601,782
14	$12,936,290	0.650	$8,702,589	17.00%	$1,479,440	$66,084	$302,407	$174,052	$1,955,899	$2,021,983	$532,451
15	$12,936,290	0.625	$8,400,181	17.00%	$1,428,031	$68,067	$302,407	$168,004	$1,898,442	$1,966,508	$470,766
16	$12,936,290	0.600	$8,097,774	17.00%	$1,376,622	$70,109	$302,407	$161,955	$1,840,984	$1,911,093	$415,909
17	$12,936,290	0.575	$7,795,367	17.00%	$1,325,212	$72,212	$302,407	$155,907	$1,783,527	$1,855,739	$367,148
18	$12,936,290	0.550	$7,492,960	17.00%	$1,273,803	$74,378	$302,407	$149,859	$1,726,070	$1,800,448	$323,826
19	$12,936,290	0.525	$7,190,552	17.00%	$1,222,394	$76,609	$302,407	$143,811	$1,668,612	$1,745,222	$285,358
20	$12,936,290	0.500	$6,888,145	17.00%	$1,170,985	$78,908	$302,407	$137,763	$1,611,155	$1,690,063	$251,217
21	$12,936,290	0.475	$6,585,738	17.00%	$1,119,575	$81,275	$302,407	$131,715	$1,553,697	$1,634,972	$220,935
22	$12,936,290	0.450	$6,283,331	17.00%	$1,068,166	$83,713	$302,407	$125,667	$1,496,240	$1,579,953	$194,091
23	$12,936,290	0.425	$5,980,923	17.00%	$1,016,757	$86,225	$302,407	$119,618	$1,438,783	$1,525,007	$170,310
24	$12,936,290	0.400	$5,678,516	17.00%	$965,348	$88,811	$302,407	$113,570	$1,381,325	$1,470,137	$149,257
25	$12,936,290	0.375	$5,376,109	17.00%	$913,938	$91,476	$302,407	$107,522	$1,323,868	$1,415,344	$130,631
26	$12,936,290	0.350	$5,073,702	17.00%	$862,529	$94,220	$302,407	$101,474	$1,266,411	$1,360,631	$114,164
27	$12,936,290	0.325	$4,771,294	17.00%	$811,120	$97,047	$302,407	$95,426	$1,208,953	$1,306,000	$99,619
28	$12,936,290	0.300	$4,468,887	17.00%	$759,711	$99,958	$302,407	$89,378	$1,151,496	$1,251,454	$86,780
29	$12,936,290	0.275	$4,166,480	17.00%	$708,302	$102,957	$302,407	$83,330	$1,094,038	$1,196,995	$75,458
30	$12,936,290	0.250	$3,864,073	17.00%	$656,892	$106,045	$302,407	$77,281	$1,036,581	$1,142,626	$65,482
										TOTAL:	$21,604,304

* An annual inflation rate of 3% has been applied to the total O&M expense.

2. Groundwater

TABLE 8-6
GROUNDWATER ALTERNATIVE
ESTIMATED CAPITAL COSTS

DESCRIPTION	QUANTITY	UNITS	UNIT COST	TOTAL COST
*20" Pipeline	79,200	LF	$65	$5,148,000
Wells, including pumps, shafts, structures, and access @ 1 mgd each	4	EA	$200,000	$800,000
Land Acquisition and Easements	1	LS	$300,000	$300,000
Legal Costs	1	LS	$500,000	$500,000
Other Water Treatment Plant Improvements[1]	1	LS	$1,040,000	$1,040,000
Sub-Total				$7,788,000
20% Contingency				$1,557,600
Total Construction Cost				$9,345,600
Other Project Costs				$3,317,690
Total Project Cost				**$12,663,290**
*Assumes the use of HDPE transmission main				

[1]CTE has recommended that CIWC move forward with water treatment plant improvements to ensure compliance with water quality regulations that include carbon slurry system, filter improvements, new river intakes and upgrading of the SCADA system.

TABLE 8-7
GROUNDWATER ALTERNATIVE
ESTIMATED OPERATING COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	COST/YR
Power	1	LS	$10,000	$10,000
Heating	1	LS	$10,000	$10,000
Supplies	1	LS	$5000	$5000
Total				**$25,000**

TABLE 8-8
GROUNDWATER ALTERNATIVE
PRESENT VALUE OF REVENUE REQUIRED

A	B	C	D	E	F	G	H	I	J	K	P.V. of
Year	Total Capital Cost	Year - En Undepr. Factor	Undepreciated Capital (B x C)	Pretax Rate of Return	Dollar Rate of Return (D x E)	Total O&M Expense *	Depreciation (B x 2.50%)	Property Taxes @ 2%	Total Capital Return (F + H + I)	Total Rev. Req'mt (G + J)	Revenue Requirement @ 10%
1	$12,663,290	0.975	$12,346,708	17.00%	$2,098,940	$25,000	$316,582	$246,934	$2,662,457	$2,687,457	$2,443,142
2	$12,663,290	0.950	$12,030,126	17.00%	$2,045,121	$25,750	$316,582	$240,603	$2,602,306	$2,628,056	$2,171,947
3	$12,663,290	0.925	$11,713,543	17.00%	$1,991,302	$26,523	$316,582	$234,271	$2,542,155	$2,568,678	$1,929,886
4	$12,663,290	0.900	$11,396,961	17.00%	$1,937,483	$27,318	$316,582	$227,939	$2,482,005	$2,509,323	$1,713,901
5	$12,663,290	0.875	$11,080,379	17.00%	$1,883,664	$28,138	$316,582	$221,608	$2,421,854	$2,449,992	$1,521,252
6	$12,663,290	0.850	$10,763,797	17.00%	$1,829,845	$28,982	$316,582	$215,276	$2,361,704	$2,390,685	$1,349,480
7	$12,663,290	0.825	$10,447,214	17.00%	$1,776,026	$29,851	$316,582	$208,944	$2,301,553	$2,331,404	$1,196,379
8	$12,663,290	0.800	$10,130,632	17.00%	$1,722,207	$30,747	$316,582	$202,613	$2,241,402	$2,272,149	$1,059,974
9	$12,663,290	0.775	$9,814,050	17.00%	$1,668,388	$31,669	$316,582	$196,281	$2,181,252	$2,212,921	$938,495
10	$12,663,290	0.750	$9,497,468	17.00%	$1,614,569	$32,619	$316,582	$189,949	$2,121,101	$2,153,720	$830,352
11	$12,663,290	0.725	$9,180,885	17.00%	$1,560,750	$33,598	$316,582	$183,618	$2,060,950	$2,094,548	$734,126
12	$12,663,290	0.700	$8,864,303	17.00%	$1,506,932	$34,606	$316,582	$177,286	$2,000,800	$2,035,406	$648,543
13	$12,663,290	0.675	$8,547,721	17.00%	$1,453,113	$35,644	$316,582	$170,954	$1,940,649	$1,976,293	$572,462
14	$12,663,290	0.650	$8,231,139	17.00%	$1,399,294	$36,713	$316,582	$164,623	$1,880,499	$1,917,212	$504,862
15	$12,663,290	0.625	$7,914,556	17.00%	$1,345,475	$37,815	$316,582	$158,291	$1,820,348	$1,858,163	$444,829
16	$12,663,290	0.600	$7,597,974	17.00%	$1,291,656	$38,949	$316,582	$151,959	$1,760,197	$1,799,146	$391,547
17	$12,663,290	0.575	$7,281,392	17.00%	$1,237,837	$40,118	$316,582	$145,628	$1,700,047	$1,740,164	$344,282
18	$12,663,290	0.550	$6,964,810	17.00%	$1,184,018	$41,321	$316,582	$139,296	$1,639,896	$1,681,217	$302,382
19	$12,663,290	0.525	$6,648,227	17.00%	$1,130,199	$42,561	$316,582	$132,965	$1,579,745	$1,622,306	$265,260
20	$12,663,290	0.500	$6,331,645	17.00%	$1,076,380	$43,838	$316,582	$126,633	$1,519,595	$1,563,432	$232,394
21	$12,663,290	0.475	$6,015,063	17.00%	$1,022,561	$45,153	$316,582	$120,301	$1,459,444	$1,504,597	$203,317
22	$12,663,290	0.450	$5,698,480	17.00%	$968,742	$46,507	$316,582	$113,970	$1,399,294	$1,445,801	$177,611
23	$12,663,290	0.425	$5,381,898	17.00%	$914,923	$47,903	$316,582	$107,638	$1,339,143	$1,387,046	$154,903
24	$12,663,290	0.400	$5,065,316	17.00%	$861,104	$49,340	$316,582	$101,306	$1,278,992	$1,328,332	$134,860
25	$12,663,290	0.375	$4,748,734	17.00%	$807,285	$50,820	$316,582	$94,975	$1,218,842	$1,269,662	$117,185
26	$12,663,290	0.350	$4,432,151	17.00%	$753,466	$52,344	$316,582	$88,643	$1,158,691	$1,211,035	$101,612
27	$12,663,290	0.325	$4,115,569	17.00%	$699,647	$53,915	$316,582	$82,311	$1,098,540	$1,152,455	$87,907
28	$12,663,290	0.300	$3,798,987	17.00%	$645,828	$55,532	$316,582	$75,980	$1,038,390	$1,093,922	$75,856
29	$12,663,290	0.275	$3,482,405	17.00%	$592,009	$57,198	$316,582	$69,648	$978,239	$1,035,437	$65,273
30	$12,663,290	0.250	$3,165,822	17.00%	$538,190	$58,914	$316,582	$63,316	$918,089	$977,003	$55,991
										TOTAL:	$20,770,010

* An annual inflation rate of 3% has been applied to the total O&M expense.